

On the Evolutionary Distance Between Asclepiadaceous-Feeding Danaida and Apocynaceous- Feeding Ithomiids

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The purpose of this brief communique is to report on some preliminary larval feeding tests in which larvae of the Monarch Butterfly *Danaus plexippus* were offered the larval host plant of the ithomiid *Tithorea pinthias*, a species from the tropical wet forests of Costa Rica. *Tithorea* larvae were also offered the host plant of *D. plexippus*. Since *D. plexippus* utilizes various species of *Asclepias* in the Asclepiadaceae as larval host plants, and *T. pinthias* larvae normally feed on *Prestonia* and other apocynaceous plants, and because the Danaidae and Ithomiidae are considered to be closely related families (Ehrlich and Raven 1965 and others), these "reciprocal-exchange" feeding tests were conducted to determine whether or not each butterfly species could survive on the other's host plants. Stated somewhat differently, the ability of larvae to feed on interchanged host plants is in part a function of the degree of evolutionary divergence between danaids and ithomiids in terms of those physiological traits regulating feeding abilities. The assumption is made that *D. plexippus* is a generalized danaid phenotype while *T. pinthias* is a generalized apocynaceous-feeding phenotype, the latter distinction being made since most ithomiids are solanaceous-feeders (Ehrlich and Raven 1965). The rationale of the tests conducted as described below incorporates a check for the ability of *T. pinthias* to feed on a cultivated solanaceous plant species.

Tithorea pinthias larvae, from the time of hatching, were exposed to *Prestonia* and *Asclepias* separately, and in a choice situation in which these plants and tomato were present together. Three larvae, all from eggs from one female in Costa Rica, were used. Using four larvae in each test *D. plexippus* Linnaeus was examined on a wild host plant, *Asclepias syriaca*, *Prestonia* sp., and tomato. The *Prestonia* came from a greenhouse culture at the Milwaukee Public Museum established in 1975 from material brought from Costa Rica. In all tests the eggs were

introduced along with fresh cuttings of the host plant into a clear plastic bag. All six bags were kept in the same laboratory and under the same conditions (usually 24 degrees C at 1200 hours and 50% r.h.). When the eggs hatched, the contents of each bag were examined daily to check for feeding (leaf damage and presence of fresh fecal material) and larval survival. The experiment lasted as long as there were surviving larvae in the bags.

All of the *T. pinthias* larvae reared on *Prestonia* survived to adulthood as did all *D. plexippus* larvae reared on *Asclepias*. *Tithorea pinthias* larvae give *Asclepias* alone all died in the first instar and larvae completely ignored tomato in the choice test. *T. pinthias* larvae did not feed on *Asclepias*. All *D. plexippus* larvae given *Prestonia* died by the end of the third instar. *Danaus plexippus* larvae fed on *Prestonia*, but in the choice test fed only on *Asclepias*. The *D. plexippus* larvae that survived through the third instar on *Prestonia* were about two-thirds the size of the *Asclepias*-reared larvae in the same instar.

Although the results point to some interesting differences in response patterns by the larvae of each butterfly species to exotic plant species, sample sizes are very small. Given the relatively low population densities and patchy distributions of *T. pinthias* populations in Costa Rica (Young, unpubl. data), it is usually difficult to obtain large samples of eggs. In the discussion that follows, I assume that the patterns observed within the small samples would have also been found in large samples as well, although such effects warrant further study in carefully designed experiments with adequate replication of the tests.

The results suggests that each butterfly species is specialized to some degree in its natural host plant. Of particular interest, however, is the apparent ability of *D. plexippus* larvae to feed on an apocynaceous plant while *T. pinthias* cannot feed on an asclepiadaceous plant. Selection has possibly made *T. pinthias* more specialized as an herbivore of Apocynaceae than *D. plexippus* as an herbivore of Asclepiadaceae. The mechanism of selection, of course, implies a genetic adaptation to exploit a particular plant species. An alternative explanation would be that *D. plexippus* is more phenotypically flexible to process foodstuffs and associated plant products from the two plant families, perhaps the result of mixed physiological mechanisms present (Young 1980). Heywood (1978) has stressed the close affinities between the Asclepiadaceae and Apocyanaceae. But such flexibility has limits: while some danaids may feed interchangeably on Asclepiadaceae and Apocynaceae (Ehrlich and Raven 1965), *D. plexippus* feeds successfully (i.e., to pupation) only on Asclepiadaceae.



Fig. 1. Left: third instar larva of *Tithorea pinthias* (Godman & Salvin) on *Prestonia* sp. (Apocynaceae). Right: third instar larva of *Danaus plexippus* Linnaeus feeding on *Prestonia*. Note the defoliated portions of the leaf resulting from feeding by *D. plexippus*. The larvae of both butterflies possess mesothoracic tubercles and similar color patterns.

D. plexippus possesses chemo-behavioral sensory mechanisms for tasting and ingesting both host plant families, but the eventual death of the larvae on *Prestonia* suggests an inability to completely digest tissues or sequester toxic secondary compounds from this plant. Although Klots (1951), mentions that *D. plexippus* feeds on both Asclepiadaceae and Solanaceae, the danaiids as a group are well known for exploiting Asclepiadaceae and Apocynaceae, especially the cardenolide-containing sections of these groups (Ehrlich and Raven 1965, Duffey and Scudder 1972, Edgar *et al.* 1974). The Ithomiidae exploit both Solanaceae and Apocynaceae (Brower and Brower 1964; Ehrlich and Raven 1965) and the results presented here for *T. pinthias* suggests that the Ithomiids consist of two sections, specialized for

exploiting the two plant groups, and that interchangeable feeding probably does not occur.

If the apocynaceous-feeding habit is a primitive condition in both the danaids and ithomiids, *D. plexippus* still possesses the ability to penetrate this plant family, even if only partially successful. The trait has not been completely lost in at least one asclepiadaceous-feeding danaid. The genes regulating olfactory acuity and other aspects of the host plant location behavior for Apocynaceae have not been entirely lost from the gene pool. On the other hand, the apparently complete inability of apocynaceous-feeding ithomiids such as *Tithorea*, and perhaps *Aeria* (Young 1978), to feed on Asclepiadaceae suggests that these butterflies did not have evolutionary contact with this group, or were not preadapted to penetrate the plant family as a new ecological resource. Similarly both *Danaus* and *Tithorea* had no evolutionary contact with the Solanaceae and neither butterfly is preadapted to utilize this plant group. Although it is maintained that the Asclepiadaceae and Apocynaceae are very closely related in terms of many characteristics including secondary compound chemistry (Safwat 1962; Alston and Turner 1963), a portion of the phenotypic characteristics of each plant group creates unique spheres of selection pressures resulting in partial or total host plant specialization for danaids and ithomiids.

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